



US010902026B2

(12) **United States Patent**  
**Lau et al.**

(10) **Patent No.:** **US 10,902,026 B2**  
(45) **Date of Patent:** **Jan. 26, 2021**

(54) **BLOCK CLASSIFIED TERM**  
(71) Applicant: **LONGSAND LIMITED**, Cambridge (GB)  
(72) Inventors: **Daniel Lau**, Cambridge (GB); **Lewis Mackay**, Cambridge (GB); **Daniel Timms**, Cambridge (GB)  
(73) Assignee: **LONGSAND LIMITED**, Cambridgeshire (GB)  
(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 696 days.

(58) **Field of Classification Search**  
CPC ..... G06N 20/00; G06N 5/003; G06N 7/005; G06N 20/10; G06N 5/022; G06N 5/04; G06N 3/006; G06N 3/0454; G06N 5/027; G06N 5/043; G06N 5/046; G06F 16/285; G06F 16/90324; G06F 16/951  
See application file for complete search history.

(56) **References Cited**  
U.S. PATENT DOCUMENTS  
7,802,194 B2 9/2010 Kol et al.  
7,809,714 B1 \* 10/2010 Smith ..... G06F 16/2425 707/713

(21) Appl. No.: **15/524,122**  
(22) PCT Filed: **Nov. 27, 2014**  
(86) PCT No.: **PCT/EP2014/075782**  
§ 371 (c)(1),  
(2) Date: **May 3, 2017**  
(87) PCT Pub. No.: **WO2016/082877**  
PCT Pub. Date: **Jun. 2, 2016**

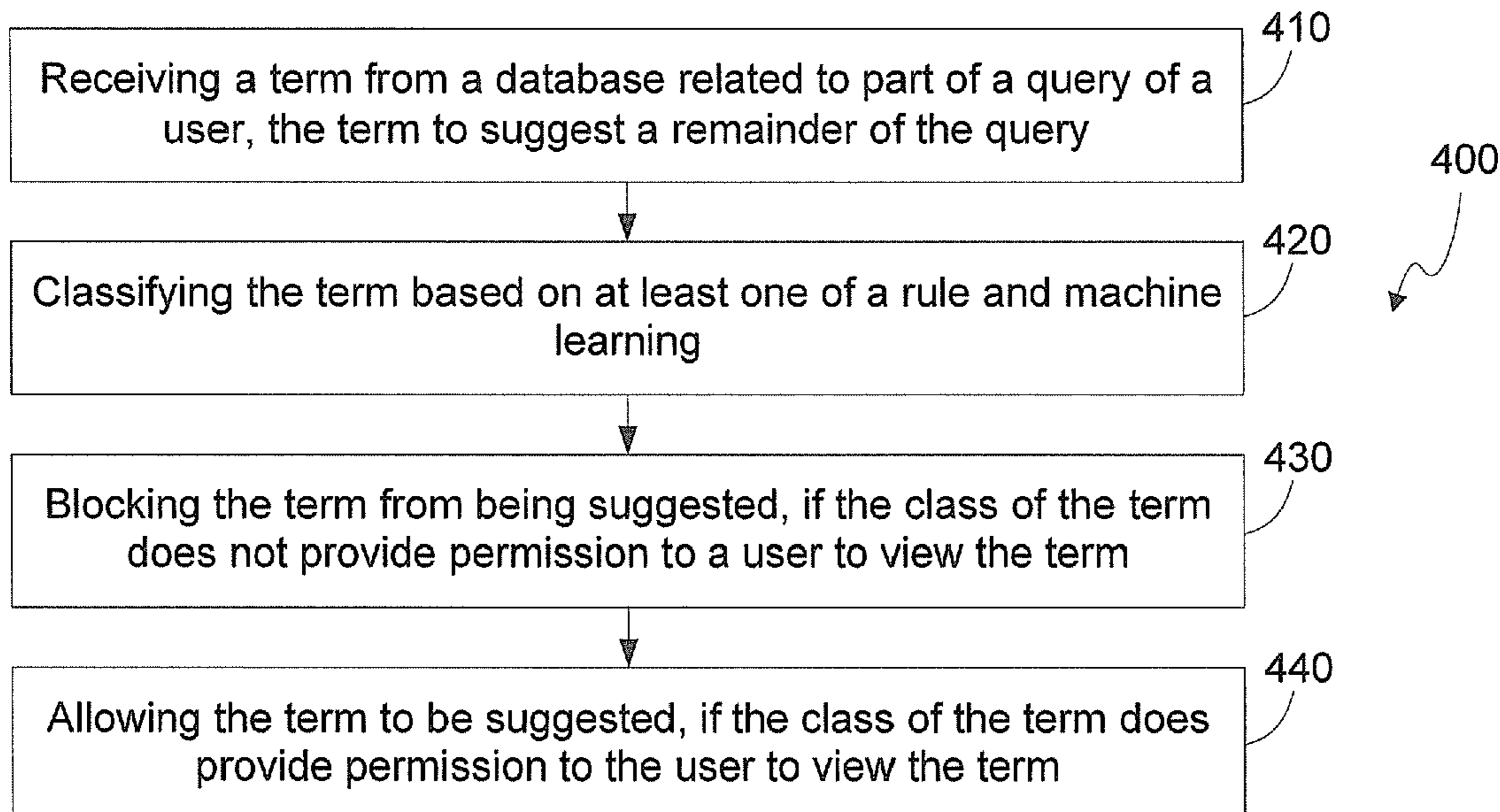
(Continued)  
FOREIGN PATENT DOCUMENTS  
CN 101281521 10/2008  
CN 102572092 7/2012  
(Continued)

(65) **Prior Publication Data**  
US 2017/0323004 A1 Nov. 9, 2017  
(51) **Int. Cl.**  
**G06N 20/00** (2019.01)  
**G06F 16/28** (2019.01)  
(Continued)  
(52) **U.S. Cl.**  
CPC ..... **G06F 16/285** (2019.01); **G06F 16/90324** (2019.01); **G06F 16/951** (2019.01);  
(Continued)

OTHER PUBLICATIONS  
Nicholas Diakopoulos, "Sex, Violence, and Autocomplete Algorithms", Aug. 2, 2013, pp. 1-4.(website: <https://slate.com/technology/2013/08/words-banned-from-bing-and-googles-autocomplete-algorithms.html>) (Year: 2013).\*  
(Continued)  
*Primary Examiner* — Paulinho E Smith

(57) **ABSTRACT**  
A class may be determined of a term from a database. The term may be blocked from being presented to a user, if the determined class does not include a permission for the user to view the term. The term may suggest a remainder of an incomplete query input by the user.

**18 Claims, 2 Drawing Sheets**



# US 10,902,026 B2

Page 2

- (51) **Int. Cl.**  
*G06F 16/951* (2019.01)  
*G06F 16/9032* (2019.01)  
*G06N 5/04* (2006.01)  
*G06N 7/00* (2006.01)
- 2016/0253403 A1\* 9/2016 Marin ..... G06F 16/283  
707/605  
2017/0177993 A1\* 6/2017 Draelos ..... G06N 3/0454  
2018/0018585 A1\* 1/2018 Marin ..... G06N 20/00

- (52) **U.S. Cl.**  
CPC ..... *G06N 5/046* (2013.01); *G06N 7/005*  
(2013.01); *G06N 20/00* (2019.01)

## FOREIGN PATENT DOCUMENTS

CN	103441986	12/2013
CN	103646109	3/2014
JP	2009-116680 A	5/2009
WO	WO-201412748	11/2014

- (56) **References Cited**

## U.S. PATENT DOCUMENTS

8,412,728 B1	4/2013	Roskind
2003/0033288 A1	2/2003	Shanahan
2009/0024590 A1	1/2009	Sturge et al.
2009/0106178 A1*	4/2009	Chu ..... G06N 20/00 706/14
2011/0264681 A1	10/2011	Kimberlin et al.
2014/0136543 A1*	5/2014	Frieden ..... G06F 16/90324 707/741
2016/0110657 A1*	4/2016	Gibiansky ..... G06N 20/00 706/12

## OTHER PUBLICATIONS

Shmuel Brody, "Cluster-Based Pattern Recognition in Natural Language Text", Aug. 2005, pp. 1-87 (Year: 2005).\*

International Search Report and Written Opinion; PCT/EP2014/075782; dated Aug. 26, 2015; 9 pages.

SEER\*DMS User Manual, "Chapter 20: Searching for Records and Patients", Jun. 25, 2011, 16 pages.

\* cited by examiner

FIG. 1

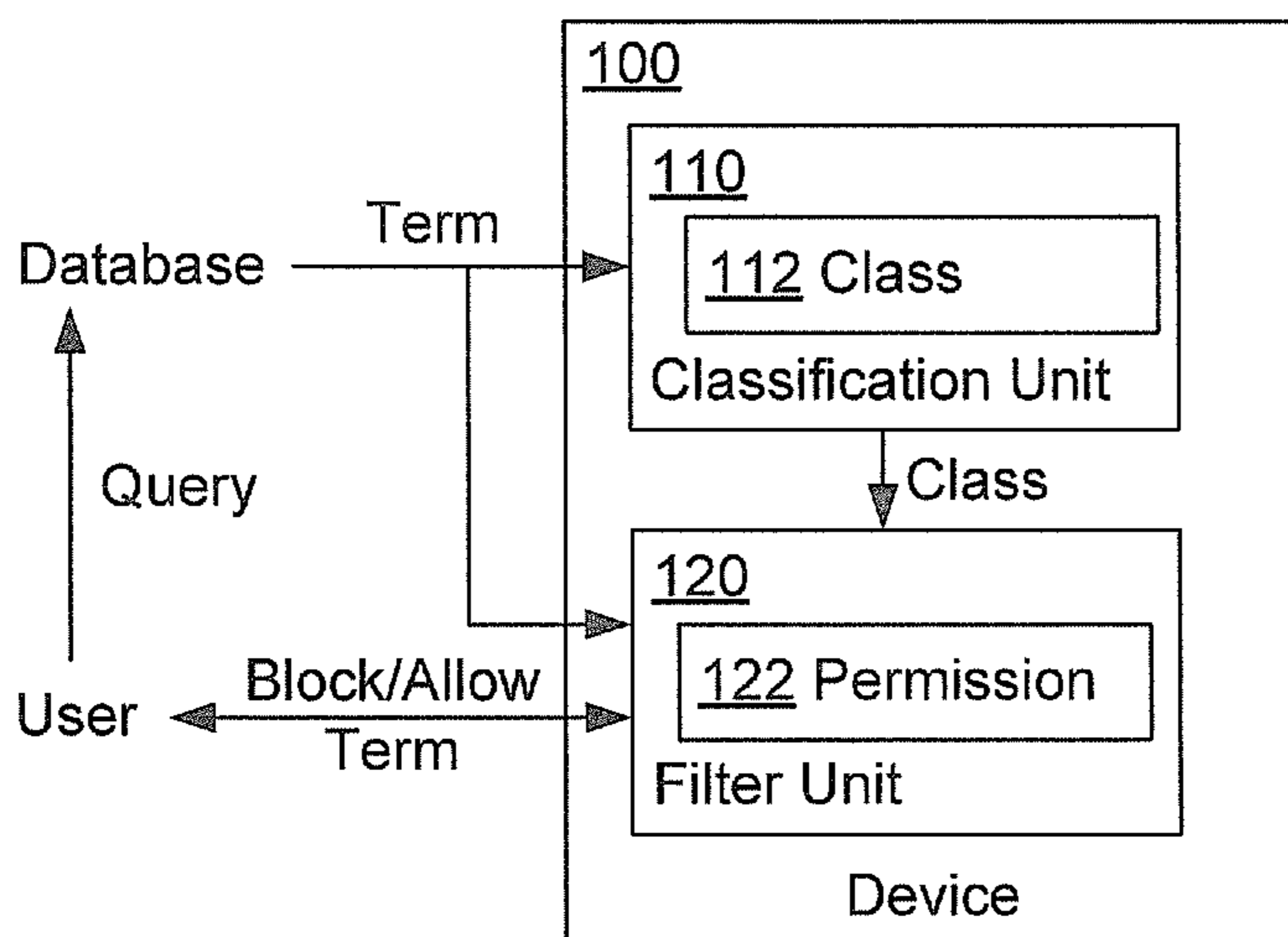
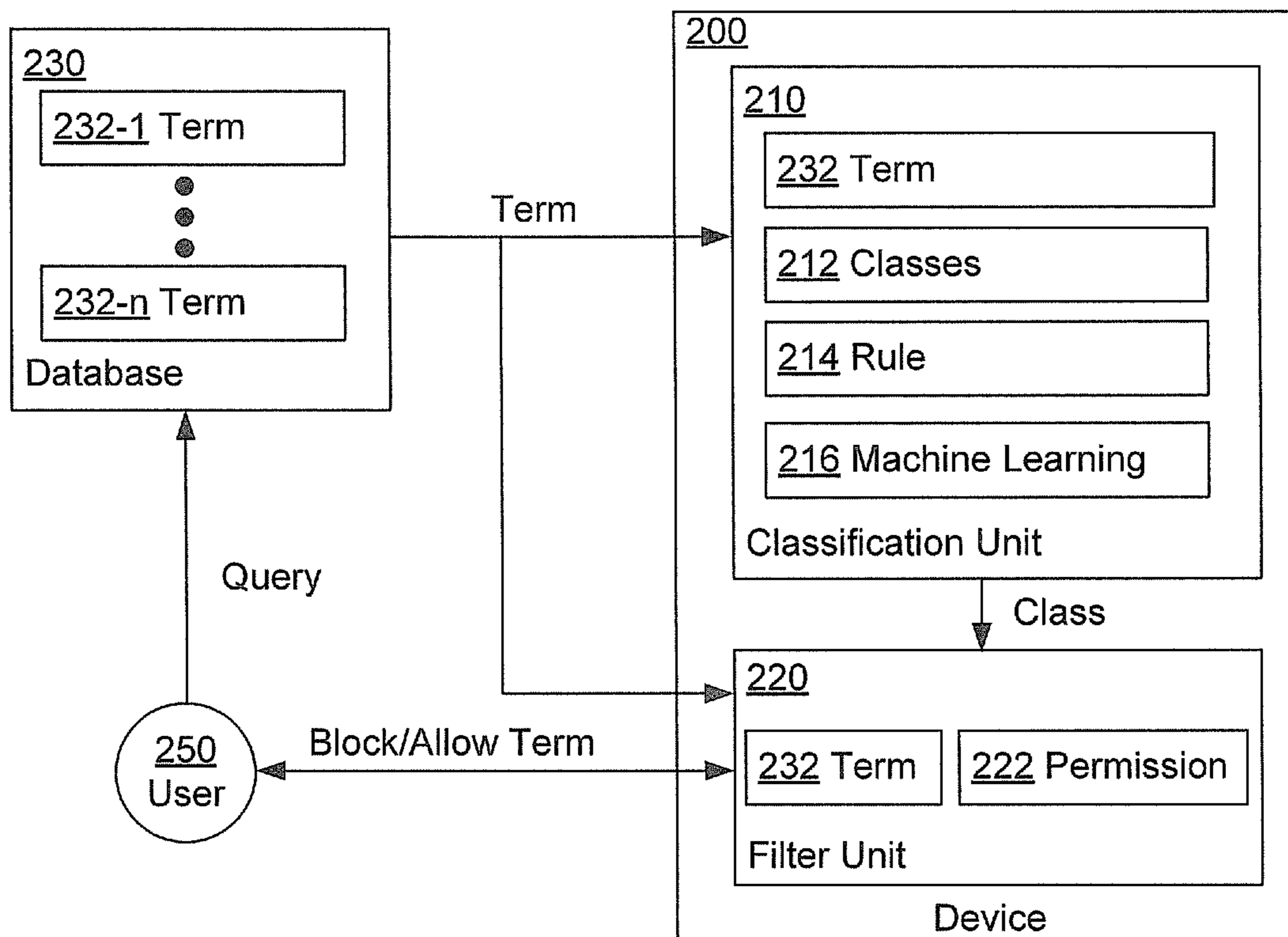
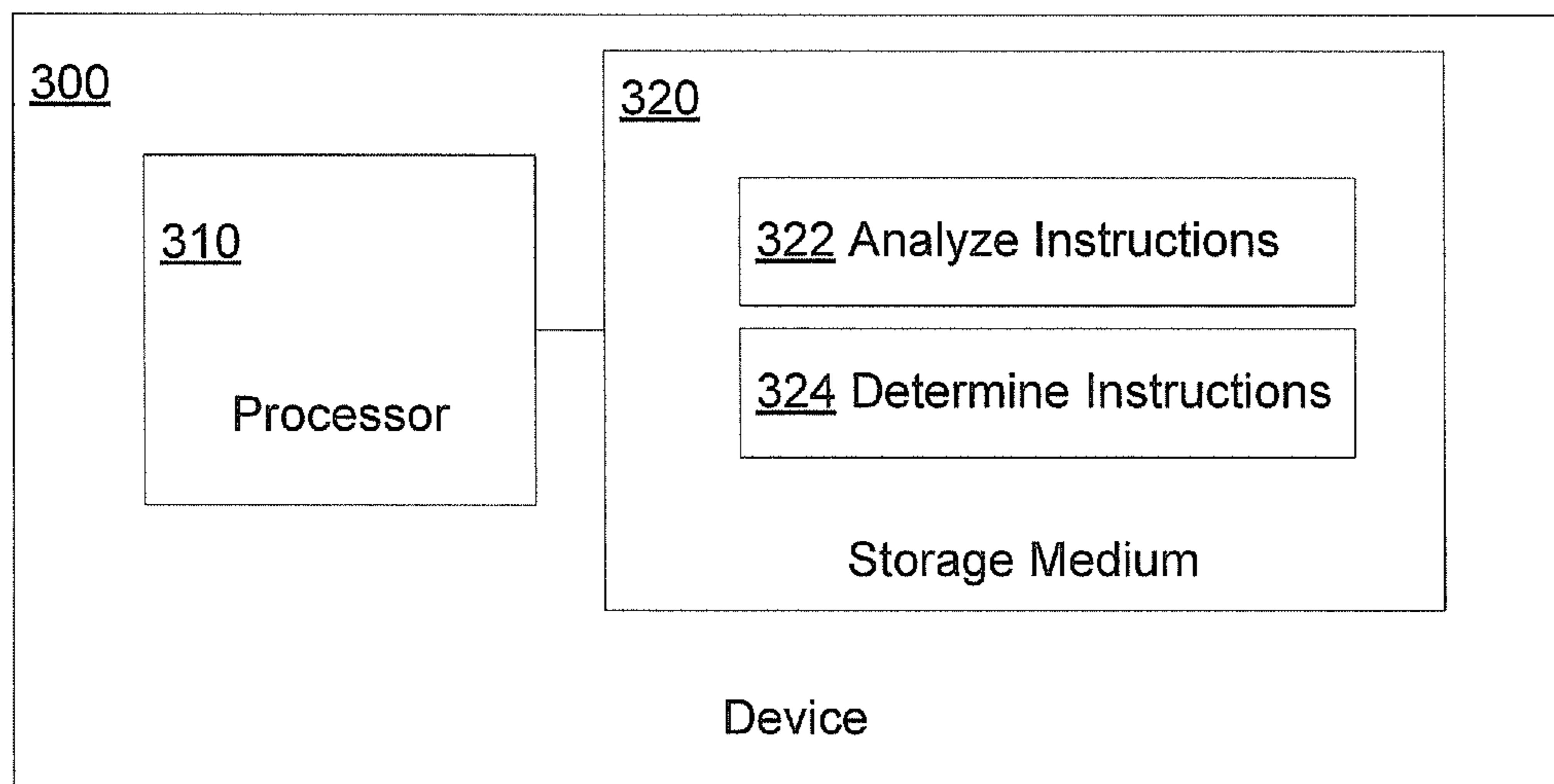


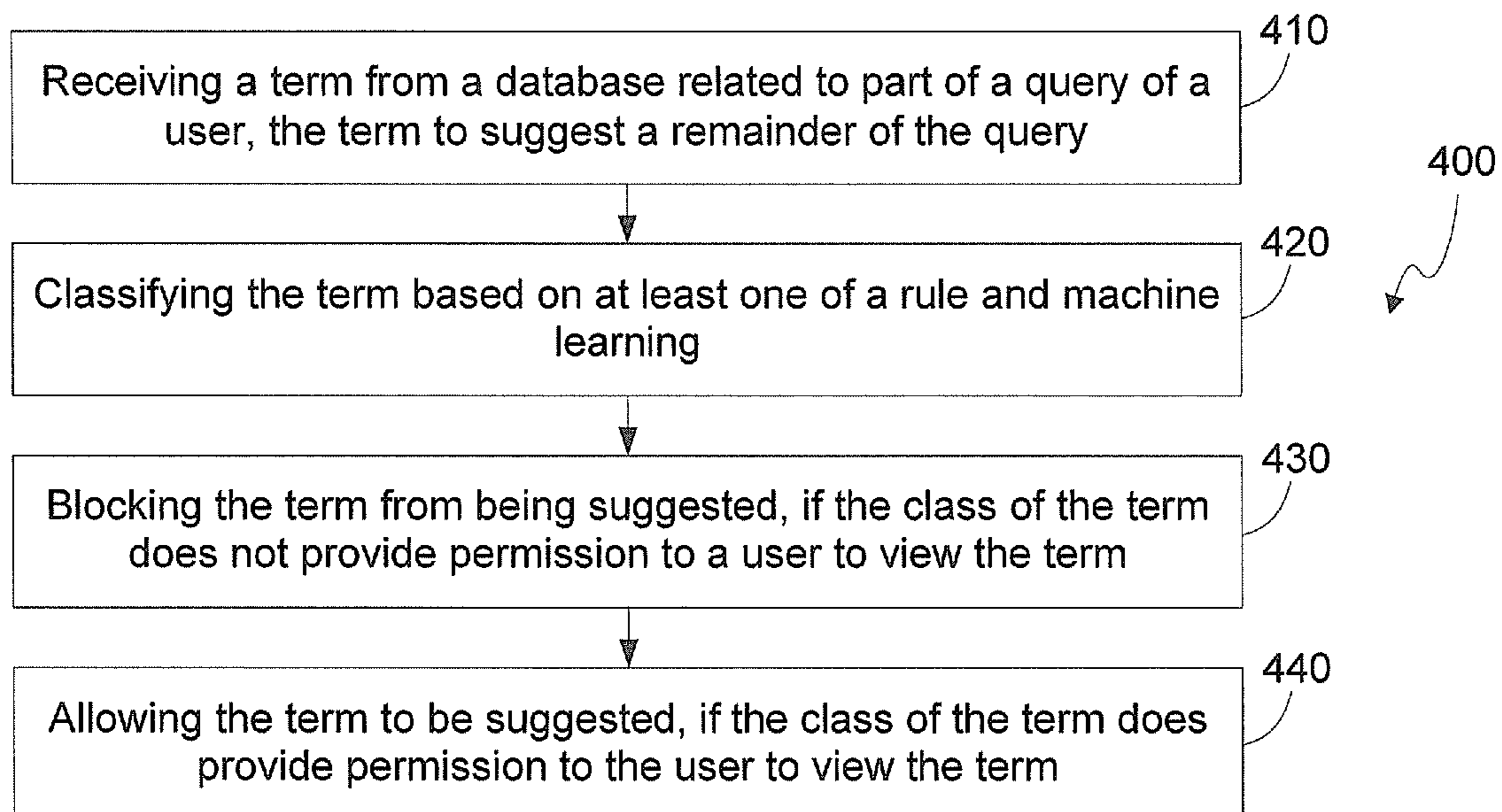
FIG. 2



# FIG. 3



# FIG. 4





**1****BLOCK CLASSIFIED TERM**

## CLAIM FOR PRIORITY

The present application is a national stage filing under 35 U.S.C. § 371 of PCT application number PCT/EP2014/075782, having an international filing date of Nov. 27, 2014, the disclosure of which is hereby incorporated by reference in its entirety.

## BACKGROUND

Device or systems may provide a feature called autocomplete, or word completion. Autocomplete may involve the device or system predicting a word or phrase that the user wants to type in without the user actually typing it in completely. Manufacturers, vendors, and/or service providers are challenged to provide improved autocomplete technologies to better assist the user.

## BRIEF DESCRIPTION OF THE DRAWINGS

The following detailed description references the drawings, wherein:

FIG. 1 is an example block diagram of a device to block a term from being presented to a user;

FIG. 2 is another example block diagram of a device to block a term from being presented to a user;

FIG. 3 is an example block diagram of a computing device including instructions for blocking a term based on a class of the term; and

FIG. 4 is an example flowchart of a method for blocking a term based on a class of the term.

## DETAILED DESCRIPTION

Specific details are given in the following description to provide a thorough understanding of embodiments. However, it will be understood that embodiments may be practiced without these specific details. For example, systems may be shown in block diagrams in order not to obscure embodiments in unnecessary detail. In other instances, well-known processes, structures and techniques may be shown without unnecessary detail in order to avoid obscuring embodiments.

Auto-completion dialogues may provide a user with suggestions from fragments of input text. For example “capit” may be auto-completed to “capital” or “capitulate.” Auto-completion may be implemented through, for example, web browsers, e-mail programs, search engine interfaces, source code editors, database query tools, word processors, and command line interpreters.

Some implementations may use either a dictionary or search engine. The search engine may only provide suggestions that return relevant items indexed into the search engine, as opposed to a dictionary where some entries may not be present. However, in some scenarios the indexed data may include sensitive information. For example, a search index of medical records could contain patient names or their social security numbers. Auto-completing sensitive information may be undesirable whilst completing non-sensitive information is beneficial to the search operator.

Filtering data using only weighting or some popularity/threshold parameter (number of documents containing terms), may not provide fine enough control to prevent leaking of sensitive information. Further, providing explicit blacklists for suggestions may filter out exact term matches.

**2**

However, manually providing and/or updating such a level of fine control may be cost-prohibitive, to the point where it is unlikely to be usefully applied.

Examples may use classification technology to filter auto-complete suggestions so that users are presented only with information they are permitted to see. An example device may determine a class a term from a database. The device may block the term from being presented to a user, if the determined class does not include a permission for the user to view the term. The term may suggest a remainder of an incomplete query input by the user.

Thus, examples may allow for finer control over what elements are filtered compared to simple weight/threshold parameters. Further, examples may allow for faster deployment and less maintenance compared to a manually maintained blacklist or whitelist of exact terms/phrases/entries.

Referring now to the drawings, FIG. 1 is an example block diagram of a device **100** to block a term from being presented to a user. The device **100** may be a microprocessor, a controller, a memory module or device, a notebook computer, a desktop computer, an all-in-one system, a server, a network device, a wireless device, or any other type of device capable of interacting with a database and/or intercepting a message along a network.

The device **100** is shown to include a classification unit **110** and a filter unit **120**. The classification and filter units **110** and **120** may include, for example, a hardware device including electronic circuitry for implementing the functionality described below, such as control logic and/or memory. In addition or as an alternative, the classification and filter units **110** and **120** may be implemented as a series of instructions encoded on a machine-readable storage medium and executable by a processor.

The classification unit **110** may determine a class **112** of a term from a database. The term may be a word or phrase used to describe a thing or to express a concept, such as a name, an address, and a social security number, and the like. The term may suggest a remainder of an incomplete query input by the user. The class **112** may relate to a system for identifying various types of terms, such as confidential and non-confidential terms.

The filter unit **120** may block a term from being presented to a user, if the determined class **112** does not include a permission **122** for the user to view the term. For instance, the determined class **112** may indicate at least one of sensitive and personally identifiable information, if the determined class **112** does not include permission **122** for the user to view the term. The filter unit **120** may allow the term to be presented to the user, if the determined class **112** includes the permission **122** for the user to view the term.

The user may be any person who is entering a query, such as by using a computer or network service, for which the database may autocomplete with the term. The user may have a user account and/or be identified by a user name and/or password. The permission **122** may relate to the whether the user has a right to view, access or modify the term. The permission **122** here may relate to whether the user may view the term triggered by the database in response to the user’s query.

For instance, if the user does not have permission to view the term based on the class **112** of the term, the filter unit **120** may block the term by preventing the term from being sent to the user and/or denying access to the term. The determined class **112** may be stored and/or associated with the term at the database, the classification unit **110** and/or the



filter unit **120**, such as via metadata. The classification and filter units **110** and **120** are explained in greater detail below with respect to FIG. **2**.

FIG. **2** is another example block diagram of a device **200** to block a term from being presented to a user. The device **200** may be a microprocessor, a controller, a memory module or device, a notebook computer, a desktop computer, an all-in-one system, a server, a network device, a wireless device, or any other type of device capable of interacting with a database and/or intercepting a message along a network.

The device **200** is shown to interface with a database **230**. The database **230** may be any electronic, magnetic, optical, or other physical storage device that contains or stores information, such as Random Access Memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage drive, a Compact Disc Read Only Memory (CD-ROM), and the like. For instance, the database **230** may include the most popular search terms **232-1** to **232-n**, where *n* is a natural number, indexed from a search engine. Further, at least some of the search terms **232-1** to **232-n**, may include personally identifiable information (PII), such as medical records, names, social security numbers and the like.

The device **200** of FIG. **2** may include at least the functionality and/or hardware of the device **100** of FIG. **1**. For example, a classification unit **210** of the device **200** of FIG. **2** may include at least the functionality and/or hardware of the classification unit **110** of the device **100** of FIG. **1** and a filter unit **220** of the device **200** of FIG. **2** may include at least the functionality and/or hardware of the classification unit **120** of the device **100** of FIG. **1**.

As noted above, the classification unit **210** may determine a class **212** of a term **232** from the database **230**. The class **212** of the term **232** may vary with respect to the user **250**. For example, the term **232** may be classified as confidential with respect to a first user but classified as non-confidential with respect to a second user. Thus, the classification unit **210** may take into account a type or identify of the user **250** when determining the class **212** of the term **232**. Different types of the users **250** may correspond to different types of classes **212**. For instance, the user's **250** account may be used to identify the type of user, such as when the user **250** logs into a system.

As also noted above, the filter unit **220** may block a term from being presented to a user **250**, if the determined class **212** does not include a permission **222** for the user **250** to view the term **232**. The filter unit **220** may allow the term **232** to be presented to the user **250**, if the determined class **212** includes the permission **222** for the user **250** to view the term **232**.

The classification unit **210** may classify the term **232** based on at least one of a rule **214** and machine learning **216**. While one rule **214** is shown, examples may include a plurality of rules. The rule **214** may indicate an operation to be performed on a number, letter, grammar, punctuation and/or syntax of the term **232**. The classification unit **210** may use the rule **214** to match the term **232** to at least one of a template and a pattern. For example, the classification unit **210** may use a rule to classify a term **232** as a social security number, if the term **232** matches a particular pattern for a social security number, as indicated by the rule **214**. The filter unit **220** may block the term **232** from being presented to the user **250**, if the term **232** is classified as a social security number.

In another example, the classification unit **210** may perform an arithmetic operation on the term **232**. In turn, the filter unit **220** may allow the term to be presented to the user **250**, if a result of the arithmetic operation satisfies the rule **214**. For instance, the classification unit **210** may classify the term **232** as a credit card number upon a result of a checksum or multiplication of the digits of the credit card or instead classify the term **232** as a date upon comparing a range and/or syntax of the term **232** to a template. Here, the filter unit **220** may block the term **232** from being presented to the user **250**, if the term **232** is classified as a credit card number or a date that falls on prohibited day.

Machine learning **216** may relate to a construction and study of algorithms that can learn from data. Such algorithms may operate by building a model based on inputs and using that to make predictions or decisions, rather than following only explicitly programmed instructions. Machine learning **216** techniques may include, for example, grammar induction and/or a probabilistic classifier. For instance, the probabilistic classifier may be a Bayesian classifier. Grammar induction may include, for example, inference by trial-and-error, a genetic algorithm, a greedy algorithm, a distributional learning algorithm and a pattern learning algorithm. The classification unit **210** may use machine learning to classify types of terms **232** that may not be easily identifiable via a rule **214**, such as addresses or spam.

As noted above, the classification unit **210** may determine a plurality of the different types of classes **212**, based on the plurality of terms **232-1** to **232-n** included in the database **230**. The types of classes **212** may relate to different security clearances. Further, at least one of the classes **212** may be a subset of another of the classes **212**. Thus, the filter unit **220** may compare to an identify of the user **250** to class **212** of the term **232** determine, if the user's security clearance only allows them to see a subset of the terms **232**. If the user **240** does not have security clearance, the filter unit **220** may not provide the term **232** to the user **250**, which was suggested by the database in response to the user's **250** query.

The classification unit **210** may determine a plurality of the classes **212** of the terms **232** simultaneously. Similarly, the filter unit **220** may block and/or allow a plurality of the terms **232** simultaneously. Thus, examples may remove or prevent terms **232** from being suggested to the user **250** that are classified as not to be presented to the user **250**. Further, PII is just one example of a type classification that could be filtered upon by the filter unit **220**. Examples may determine a class **212** of a term **232**, based on any type of criteria deemed appropriate for denying to the term **232**.

FIG. **3** is an example block diagram of a computing device **300** including instructions for blocking a term based on a class of the term. In the embodiment of FIG. **3**, the computing device **300** includes a processor **310** and a machine-readable storage medium **320**. The machine-readable storage medium **320** further includes instructions **322** and **324** for blocking the term based on the class of the term.

The computing device **300** may be included in or part of, for example, a microprocessor, a controller, a memory module or device, a notebook computer, a desktop computer, an all-in-one system, a server, a network device, a wireless device, or any other type of device capable of executing the instructions **322** and **324**. In certain examples, the computing device **300** may include or be connected to additional components such as memories, controllers, etc.

The processor **310** may be, at least one central processing unit (CPU), at least one semiconductor-based microprocessor, at least one graphics processing unit (GPU), a microcontroller, special purpose logic hardware controlled by



5

microcode or other hardware devices suitable for retrieval and execution of instructions stored in the machine-readable storage medium **320**, or combinations thereof. The processor **310** may fetch, decode, and execute instructions **321**, **323**, **325**, **327** and **329** to implement blocking the term based on the class of the term. As an alternative or in addition to retrieving and executing instructions, the processor **310** may include at least one integrated circuit (IC), other control logic, other electronic circuits, or combinations thereof that include a number of electronic components for performing the functionality of instructions **322** and **324**.

The machine-readable storage medium **320** may be any electronic, magnetic, optical, or other physical storage device that contains or stores executable instructions. Thus, the machine-readable storage medium **320** may be, for example, Random Access Memory (RAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), a storage drive, a Compact Disc Read Only Memory (CD-ROM), and the like. As such, the machine-readable storage medium **320** can be non-transitory. As described in detail below, machine-readable storage medium **320** may be encoded with a series of executable instructions for blocking the term based on the class of the term.

Moreover, the instructions **322** and **324**, when executed by a processor (e.g., via one processing element or multiple processing elements of the processor) can cause the processor to perform processes, such as, the process of FIG. **4**. For example, the analyze instructions **322** may be executed by the processor **310** to analyze a term from a database (not shown) to determine a class, the term is to relate to part of a query and to suggest a remainder of the query. The determine instructions **324** may be executed by the processor **310** to determine if the term is to be blocked in response to the query, based on the class of the analyzed term. The class may be determined based on at least one of a rule and machine learning. For example, the term may be blocked from being presented, if a user does not have permission to the analyzed class. The term may be allowed to be presented, if the user, if the user has permission to the analyzed class.

FIG. **4** is an example flowchart **400** of a method for blocking a term based on a class of the term. Although execution of the method **400** is described below with reference to the device **200**, other suitable components for execution of the method **400** can be utilized, such as the device **100**. Additionally, the components for executing the method **400** may be spread among multiple devices (e.g., a processing device in communication with input and output devices). In certain scenarios, multiple devices acting in coordination can be considered a single device to perform the method **400**. The method **400** may be implemented in the form of executable instructions stored on a machine-readable storage medium, such as storage medium **320**, and/or in the form of electronic circuitry.

At block **410**, the device **200** receives a term **232** from a database **230** related to part of a query of a user **250**. The term **232** may suggest a remainder of the query. At block **420**, the device **200** may classify the term based on at least one of a rule **214** and machine learning **216**. The machine learning **216** may include at least one of grammar induction and a probabilistic classifier to classify the term **232**. The rule **214** may match the term to at least one of a template and a pattern to classify the term **232**.

At block **430**, the device **200** blocks the term **232** from being suggested, if the class **212** of the term **232** does not provide permission **222** to a user **250** to view the term **232**. At block **440**, the device **200** allows the term to be sug-

6

gested, if the class **212** of the term **232** does provide permission **222** to the user **250** to view the term **232**.

We claim:

1. A device, comprising:
  - a processor; and
  - a non-transitory computer-readable storage medium on which is stored instructions that, when executed by the processor, cause the processor to:
    - determine a class of a term received from a database based on a rule and/or machine learning, wherein the rule is used to match the term to a template and/or a pattern;
    - perform an arithmetic operation on the term, wherein the arithmetic operation is a checksum or a multiplication of a plurality of digits included in the term;
    - determine the class of the term based on a result of the arithmetic operation satisfying the rule, wherein the term is to suggest a remainder of an incomplete query; and
    - block the term from being presented to a user based on the determined class of the term not providing a permission for the user to view the term, or allow the term to be presented based on the class of the term providing the permission for the user to view the term.
2. The device of claim **1**, wherein the instructions cause the processor to:
  - classify the term based on the machine learning, and the machine learning includes a grammar induction and/or a probabilistic classifier.
3. The device of claim **2**, wherein,
  - the probabilistic classifier includes a Bayesian classifier; and
  - the grammar induction includes an inference by trial-and-error, a genetic algorithm, a greedy algorithm, a distributional learning algorithm, and/or a pattern learning algorithm.
4. The device of claim **1**, wherein the instructions cause the processor to:
  - classify the term based on the rule, wherein the rule indicates an operation to be performed on a number, letters, and/or a syntax of the term.
5. The device of claim **1**, wherein
  - different types of users correspond to different types of classes.
6. The device of claim **5**, wherein the instructions cause the processor to:
  - determine a plurality of the different types of classes based on a plurality of terms included in the database, wherein the plurality of terms included in the database are mined from data indexed into a search engine.
7. The device of claim **6**, wherein,
  - the plurality of the different types of classes relate to different security clearances, and
  - one of the plurality of the different types of classes is a subset of another of the plurality of the different types of classes.
8. The device of claim **1**, wherein,
  - the term includes a name, an address, and/or a social security number, and
  - the class of the term indicates sensitive and/or personally identifiable information when the class of the term does not include the permission for the user to view the term.
9. The device of claim **1**, wherein the instructions cause the processor to:



7

determine a plurality of classes of terms simultaneously,  
and

block and/or allow a plurality of terms simultaneously.

**10.** The device of claim **1**, wherein the instructions cause  
the processor to:

classify the class of the term as a date based on a  
comparison of a range and/or a syntax of the term to the  
template and/or the pattern.

**11.** A method, comprising:

receiving a term from a database related to part of a query  
of a user, the term to suggest a remainder of the query;  
classifying the term based on a rule and/or machine  
learning;

performing an arithmetic operation on the term, wherein  
the arithmetic operation is a checksum or a multipli-  
cation of a plurality of digits included in the term;

determining the class of the term based on a result of the  
arithmetic operation satisfying the rule;

blocking the term from being suggested based on the class  
of the term not providing a permission to the user to  
view the term; or

allowing the term to be suggested based on the class of the  
term providing the permission to the user to view the  
term.

**12.** The method of claim **11**, wherein,

the machine learning includes a grammar induction and/or  
a probabilistic classifier to classify the term, and

the rule is to match the term to a template and/or a pattern  
to classify the term.

**13.** The method of claim **11**, further comprising:

determining a plurality of classes of terms simultane-  
ously; and

blocking and/or allowing a plurality of terms simultane-  
ously.

**14.** A non-transitory computer-readable storage medium  
storing instructions that, when executed by a processor of a  
device, cause the processor to:

8

analyze terms received from a database to determine a  
plurality of classes of the terms, the terms relating to a  
part of a query and to suggest a remainder of the query;  
perform an arithmetic operation on the terms, the arith-  
metic operation being a checksum or a multiplication of  
a plurality of digits included in the terms;

determine the plurality of classes of the terms based on a  
result of the arithmetic operation satisfying a rule; and  
determine whether a plurality of the terms are to be  
blocked and/or allowed in response to the query based  
on the plurality of classes of the terms.

**15.** The non-transitory computer-readable storage  
medium of claim **14**, wherein the instructions cause the  
processor to:

block the plurality of the terms from being presented  
based on a user not having a permission to the plurality  
of classes of the terms, and

allow the plurality of the terms to be presented, based on  
the user having the permission to the plurality of  
classes of the terms.

**16.** The non-transitory computer-readable storage  
medium of claim **14**, wherein the instructions cause the  
processor to:

match the terms to a template and/or a pattern based on  
the rule.

**17.** The non-transitory computer-readable storage  
medium of claim **14**, wherein the instructions cause the  
processor to:

determine the plurality of classes of the terms simultane-  
ously, and

block and/or allow the plurality of the terms simultane-  
ously.

**18.** The non-transitory computer-readable storage  
medium of claim **14**, wherein the instructions cause the  
processor to:

determine the plurality of classes of the terms based on the  
rule and machine learning.

\* \* \* \* \*